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Objective 1: Establish C-17 Technical Library; Complete Deployment of LiveLink Distribution System
Objective 2: Improve Data Analysis (Telemetry) Toolset and Products; Train Users
Objective 3: Modernize Legacy Databases/Applications (Measurands, Calibrations, Generation of the Test Parameter Requirements [TPR] Document)
Objective 4: Fix the Test Planning and Test Point Tracking User Interface
Objective 5: Implement the Approved ETDMS Framework

Collaterally, the C-17 ETDMS will support the efforts of our co-located NASA-Dryden colleagues seeking to improve the abilities of our National Airspace System (NAS) to support industry initiatives such as aircraft health monitoring and "call-ahead" maintenance planning.

**15. SUBJECT TERMS** ILIAD-instrumentation loading, integration, analysis, and decommutation VPN-Virtual Private Network ETDMS-Enterprise Test Data Management System TPR-Test parameter requirements COTS-commercial off-the-shelf TSPI-time-space-position information TB-Terabytes AMP-Avionics Modernization Program GB-Gigabytes EU-engineering unit

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# C-17 TEST DATA ARCHIVE EFFORT

Major James (Monty) Greer
412 TW/DRP, Edwards AFB, CA

Mr. Dwight Fuqua
412 TW/ENIO, Edwards AFB, CA

*The C-17 Test Director, Major James (Monty) Greer is currently deployed to the Southwest Asian Area of Responsibility (AOR). In his absence, First Lieutenant Mike Perez, Glenn Sakamoto, Jeff Armbruster, Bill Kubel, and I completed this paper with contributions by many others cited herein; we hope it meets his goals. Major Greer is a boss one looks up to; we anxiously await his safe return to the CONUS.*

## ABSTRACT.

During the era 2000-2002, the U.S. Air Force C-17 Follow-on Flight Test Program (FOFTP) transitioned to total bulk data collection employing the Veridian OMEGA™ Intelligent Multiplexer (IMUX) and associated Series 3000 Telemetry Processor. Advanced planning for the data management was deficient; engineers and analysts were overwhelmed by the actual quantity of instrumentation data collected, at a rate of 2- to 3-gigabytes per flight test hour.

In fiscal year (FY) 2003, the Test Director initiated comprehensive planning for management of the C-17 data elements. Including the bulk instrumentation data collected, this plan also addressed the management of programmatic information and correlation from the test definition program phase through the archiving of test reporting Information. The envisioned end-state of the C-17 test data archive effort, also referred to as the C-17 Enterprise Test Data Management System (ETDMS), seeks to provide the C-17 Test Team with cradle-to-grave data management at a level unprecedented in the flight test community and is described herein.

With Congressionally directed funding for the effort, the C-17 Integrated Product Team (IPT) has aggressively moved into deploying the C-17 ETDMS at the Air Force Flight Test Center (AFFTC) located at Edwards Air Force Base, California. Five modest objectives were set for the effort at initiation; these were:

- Objective 1: Establish C-17 Technical Library; Complete Deployment of LiveLink Distribution System
- Objective 2: Improve Data Analysis (Telemetry) Toolset and Products; Train Users
- Objective 3: Modernize Legacy Databases/Applications (Measurands, Calibrations, Generation of the Test Parameter Requirements [TPR] Document)
- Objective 4: Fix the Test Planning and Test Point Tracking User Interface
- Objective 5: Implement the Approved ETDMS Framework

The C-17 ETDMS will link the many geographically separated users of C-17 test results in near real-time. Thus, providing the program decision-makers with the information required to support the current worldwide combat operations tempo by joint force elements as exhibited during the recent deployments and sustainment of operations in the Southwest Asian AOR. Collaterally, the C-17 ETDMS will support the efforts of our co-located NASA-Dryden colleagues seeking to improve the abilities of our National

Airspace System (NAS) to support industry initiatives such as aircraft health monitoring and "call-ahead" maintenance planning.

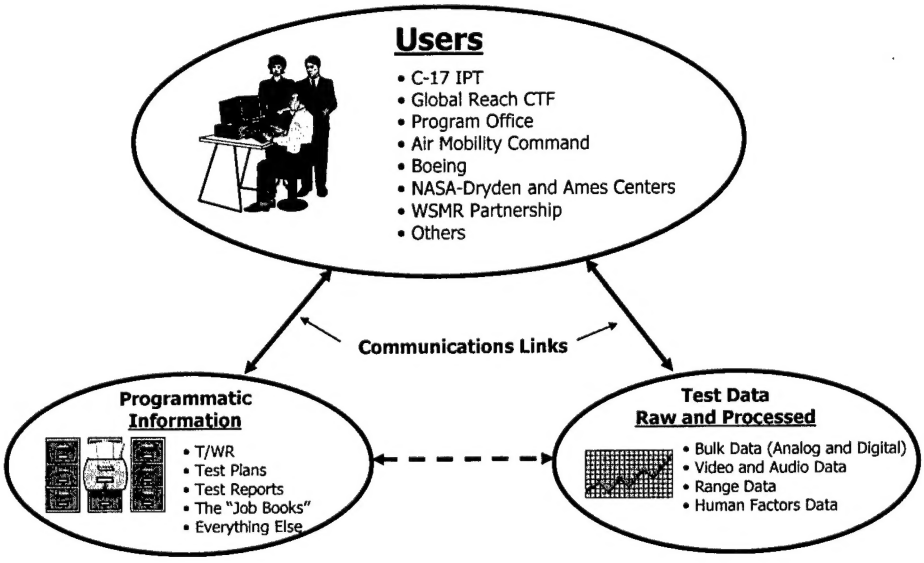
Currently ahead of schedule and within projected costs boundaries, the C-17 ETDMS will provide government off-the-shelf (GOTS)/commercial off-the-shelf (COTS) solutions to the C-17 test community during FY 2004.

**PROBLEM STATEMENT.**

C-17 data management encompasses: (1) programmatic information elements; and (2) flight test data elements. Programmatic information includes the test plans, flight cards, Type-2 (T-2) modification packages, program schedules, and test reports. Flight test data elements include instrumentation data, video and audio data, completed flight cards, range support data, and time-space-position information (TSPI).

The problem is twofold: (1) management of over 10 years of historical data complicated by deployment of total bulk data capture capability; and (2) access to the information from a broad, geographically separated C-17 IPT, as shown in Exhibit A. Large amounts of information and data are required to be linked to the users shown; data communications capabilities were limited to electronic mail and 10 Base T network access to a LiveLink™ Document Management System.

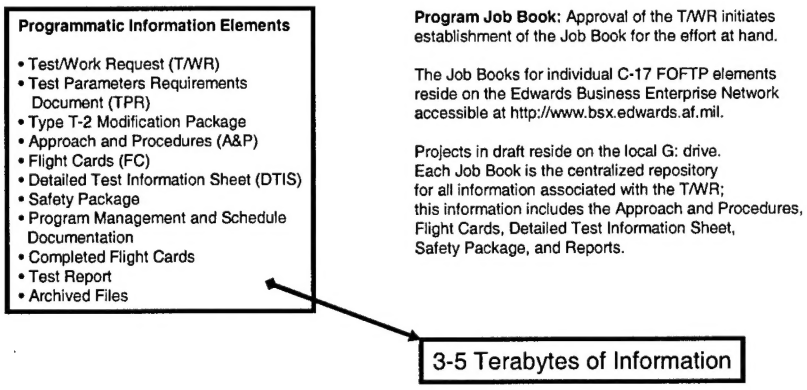
**Exhibit A: The Problem**



## *How much information/data are we talking about?*

Programmatic Information Elements. We currently show a short-term need to manage 3- to 5-Terabytes (TB) of information which will grow to 25 TB over the life of the C-17 FOFTP. Exhibit B shows typical programmatic information elements.

**Exhibit B: Amount of Programmatic Information**




Flight Test Data Elements. Our current flight test data processing baseline is 3- to 6-TB on any given day. We anticipate this to double before the close of FY 2004, and quadruple by end of FY 2005. By FY 2006, we expect to manage an estimated 25 TB of information per year. We can only hope to stay ahead of this data deluge. Exhibit C outlines flight test data elements being collected per mission flight hour.

## INTRODUCTION.

The key to success in any effort is a "common vision." Those involved have the same viewpoint and expectations of the anticipated results and a mutual understanding of requirements. We now work in the so-called "spiral development" mode, anticipating block-type upgrades to capabilities incrementally delivered, which may be modified as requirements become more defined, and integrating the most recent technologies as they become available.

Using this approach, the C-17 test data archive effort establishes a baseline for future data management at the AFFTC, strategies and tactics to address C-17 program management objectives, but also, addresses the broader concerns faced by future programs including the Joint Strike Fighter (JSF), and C-130 Avionics Modernization Program (AMP).

## Exhibit C: Amount of Flight Test Data

**Flight Test Data Elements**

- ILIAD Database
- OMEGA Database
- Display Files
- OMEGA Output Files (DRU & ODE)
- Dolce Output Files
- Range Data Files
- Weather Data Files
- Video (Digital & Analog)
- Audio (Digital & Analog)
- Photos
- OMEGA Files
- CSV Files
- MATLAB® Files
- DDD Files
- HD4 and 5 Files
- MPEG Files
- Other Special Data Products
- Archived Files

**MIL-STD-1553 Data Bus:** Currently seven busses are instrumented on the designated test aircraft; two additional communications data busses will be instrumented in the future.

- M1 / M2 busses produce ~ 350 MB per hour each
- F1 / F2 / F3 / F4 produce ~ 250 MB per hour each
- W1 ~ 300 MB per hour
- ***Total 1553 ~ 2GB per hour***

**ARINC 429 Data Bus:** On the designated test aircraft, 36 high and low speed busses are captured.

- ***Aggregate total ~ 300 MB per hour***

**Pulse Code Modulated (PCM) Analog Data:** Three PCM streams are captured on the designated test aircraft, each at a data rate of 640KBPS.

- ***Aggregate total ~ 900 MB per hour***

**Analog and Digital Video Data:** Currently VHS and Super 8 tape cassettes record audiovisual data; transition to solid state digital recorders has been implemented on the second test aircraft.

- On demand copy of VHS to DVD format capability exists
  - Converted VHS/Super 8 Data ~ 2 GB per hour for specified time slices consolidating 3 video streams
  - Digital Solid State Recorder (Heim Brand) ~1.1 GB per hour per video stream.

*More to come* ⟶

## Exhibit C: Amount of Flight Test Data (Concluded)

**Flight Test Data Elements**

- ILIAD Database
- OMEGA Database
- Display Files
- OMEGA Output Files (DRU & ODE)
- Dolce Output Files
- Range Data Files
- Weather Data Files
- Video (Digital & Analog)
- Audio (Digital & Analog)
- Photos
- OMEGA Files
- CSV Files
- MATLAB® Files
- DDD Files
- HD4 and 5 Files
- MPEG Files
- Other Special Data Products
- Archived Files

**ILIAD and OMEGA Databases:** For each test series profile, assume 100GB of supporting data.

**Data Products:** For data bus and PCM instrumentation, archives will be twice the size of data/flight hour collected (best case). Video experience to date is on the same level of magnitude.

**Still Photo Data:** On-aircraft, in-flight or post-mission digital camera data indicates a file size ~ 0.5 GB per photo for high quality archives.

**Range Radar/Beacon TSPI Data:** Recent parachute airdrops collected FPS-16 data from a single range radar.
Processed, this data indicates a file size ~ 1 MB/mission.
Additional data processing reduces this to ~ of 0.5 MB/mission.

**Range Video Support:** White Sands Missile Range (WSMR), New Mexico, provides state-of-the-art digital video in support of munitions programs.
This capability is coming soon to other DOD ranges.
Up to six cameras are used to score Air Force bomb drops and guided air-to-ground missile performance.
Typically 8 seconds is recorded for each test point or event.
Our colleagues have provided the following information. Current digital camera is 1 MB/frame (1024x1024), 1,000 frames per second, net result on the order of 62.9 GB/minute/camera.
If we have 20 cameras deployed, then we're looking at ~1.26 TB/minute.
The next generation cameras are 4 MB/frame & higher frame rates.
But assume still 1,000 frames per second, and then we're looking in the neighborhood of 5 TB/minute.

The principle sponsors for the effort are Major James (Monty) Greer and Major Paul Waters. Major Greer was the C-17 Test Director for the US Air Force through August of 2004; he is currently deployed in the Southwest Asian AOR with Major Landon Henderson is now holding the reins of authority and continuing the program.

Major Waters is vested as the AFFTC lead for formulation of Joint Center strategies to tackle upcoming test and evaluation programs. First Lieutenant Miguel (Mike) Perez is the U.S. Air Force designated Program Manager for the C-17 test data archive effort.

Mr. Steve Parker leads the Instrumentation Team assigned to the C-17 effort; he also leads associated efforts for platforms including the C-130 and C-135.

Mr. Dwight Fuqua and Mr. Jeff Armbruster are First Lieutenant Perez's technical advisors bringing over 10 years of post-military career industry experience to bear on integration of commercial and Government-developed technologies to meet the mission needs. Glenn Sakamoto coordinates activities with our NASA-Dryden Center colleagues.

Directed line item congressional funding on the order of $2.7M was provided for FY 2004, specifically earmarked to establish and implement the C-17 test data archive effort. Previously, during the era 2000-2003, the C-17 FOFTP invested over $2M in bulk data collection and processing capabilities. Anticipated funding for FY 2005 is earmarked at $3M.

## BACKGROUND.

Programmatic Information Elements.

The existing technical library was swamped with over 12,000 documents, many in duplicate, and available in paper copy only. The C-17 information was interspersed with other heavy aircraft programs dating back to 1968. Information was not indexed or readily available; information resident at the System Program Office and/or Boeing Long Beach was not readily accessible.

A meager 25 Gigabytes (GB) of storage crippled the LiveLink™ Document Management System and low bandwidth accessibility by those geographically separated IPT users needing information right now.

Flight Test Data Elements.

Legacy elements residing in the technical library consisted of 1,800 14-inch magnetic reel-to-reel tapes; 3,800 videotape cartridges; and over 200 volumes of completed flight test cards in paper-only media. As mentioned, C-17 information was interspersed with other heavy aircraft programs dating back to 1968.

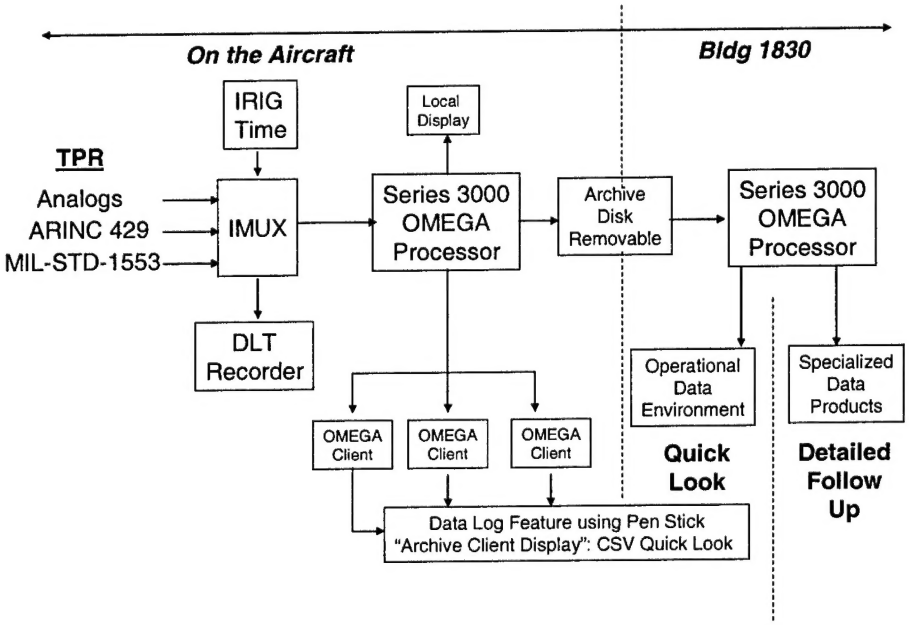
The deployment of the Veridian bulk data collection system onto the dedicated C-17 airframe (airframe designation T-1) was initially a disaster; the US Air Force purchased three complete systems, as of January 2002: one was operational, one unit was partially operational, and one was still sitting in the box. On the post-mission data processing side, an equal challenge faced the team, collecting 3 GB of flight data per hour; processing was swamped with only 35 GB of total storage space to disseminate the information to the flight test engineers and cognizant, discipline engineers.

On the data processing side (i.e., input-output) files had to be deleted to take care of the next job, then re-processed from raw data tapes, as the information was needed. Here, the data management concept was wholly inadequate; capacity could not handle production of data items.

All issues were addressed in parallel. Three Veridian systems were activated by September 2002: one supported the dedicated test aircraft T-1; another palletized system used to test designated production aircraft; and a third hot-bench system was employed for preflight checkout of instrumentation configuration changes. Ms. Kim Lathrop, our Type-2 Modification Manager led this assault supported by Leo Gross, Bill Wambganns, and Bill Huang. Subsequently, this team deployed a fourth system for the second dedicated test C-17 deployed to Edwards in mid-2004.

Exhibit D highlights the C-17 data chain for the resultant instrumentation-data processing capabilities now in-use. The IMUX collects analog and digital data bus elements, time-tagging and archiving this bulk data capture onto digital linear tape (DLT) cartridges; the IMUX forwards the information to the on-board Series 3000 OMEGA™ processor where engineering unit (EU) conversion takes place for real time display to the flight test crew on client notebook PCs. Redundant archive to removable hard disk drive (HDD) is performed; post-mission the HDD is transported to the data processing facility for detailed processing and analysis, and data product generation. The other data sources, video, audio, range, and TSPI sources are not shown here.

**Exhibit D: C-17 Instrumentation-Data Processing Chain**




In parallel to making this process and system operational, an emulator facility was established allowing our cognizant engineers to pre-fly a mission, configure their displays, and dry run the test mission before flying it, thus avoiding the errors with "winging it." Mr. Reuben Nelson was the instrumental figure in this initiative.

As a "gap-filler," Mr. Christopher Coleman solved the data storage dilemma with the recommendation to employ temporarily the Universal Serial Bus (USB) Version 2.0 Buslink™ portable drives to warehouse data. Mr. Coleman's recommendations went into place within 24 hours and data storage capacity rose from the 35 GB baseline to over 1.2 TB in one week, albeit segmented on multiple drives.

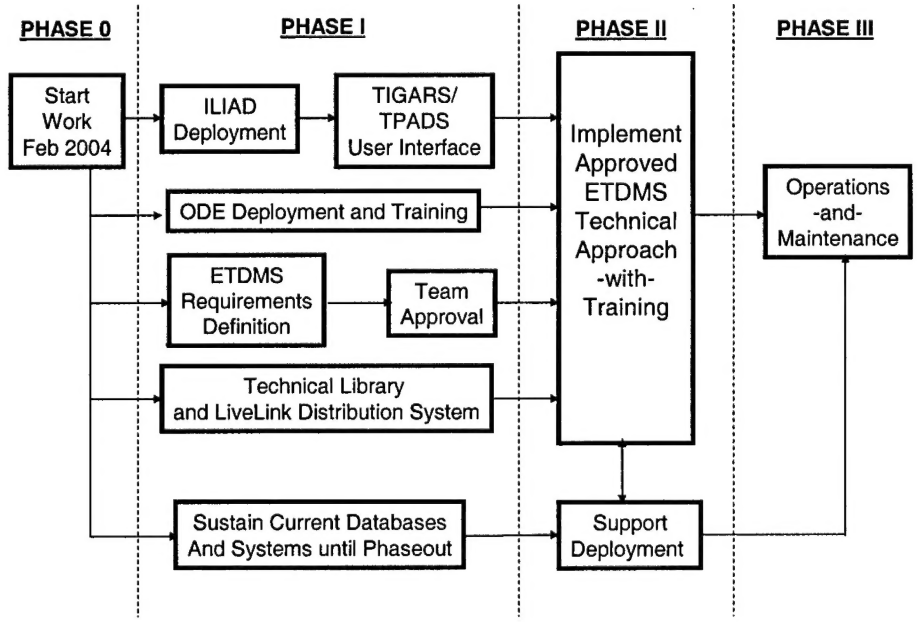
To meet this challenge, five objectives were initially established; these were:

- Objective 1: Establish C-17 Technical Library; Complete Deployment of LiveLink Distribution System
- Objective 2: Improve Data Analysis (Telemetry) Toolset and Products; Train Users
- Objective 3: Modernize Legacy Databases/Applications (Measurands, Calibrations, Generation of the Test Parameter Requirements [TPR] Document
- Objective 4: Fix the Test Planning and Test Point Tracking User Interface
- Objective 5: Implement the Approved ETDMS Framework

Research and bid-sample testing was conducted to support development of the technical approach, schedule, and budget allocations. Government off-the-shelf and COTS tools were identified to support the technical approach. Examples are: (1) OMEGA™ data environment; (2) instrumentation loading, integration, analysis, and decommutation (ILIAD); (3) Microsoft Sharepoint™; and (4) FOXPRO™ Version 8.0.

A three-phase technical approach was adopted to meet urgent, critical shortcomings aimed at reaching the end-state in FY 2005 fielding the needed capabilities as fast as possible. Exhibit H highlights the technical approach.

**Exhibit H: Technical Approach**




## RESULTS TO DATE.

What we have achieved to date is discussed by objective below.

Objective 1: Establish C-17 Technical Library; Complete Deployment of Live Link Distribution System.

## DEFINITION OF THE ROADMAP.

We then proceeded to define and address the core problems with a spiral development approach: (1) management of over 10 years of historical data complicated by deployment of total bulk data capture capability; and (2) access to the information from a broad, geographically separated C-17 IPT, as previously shown in Exhibit A.

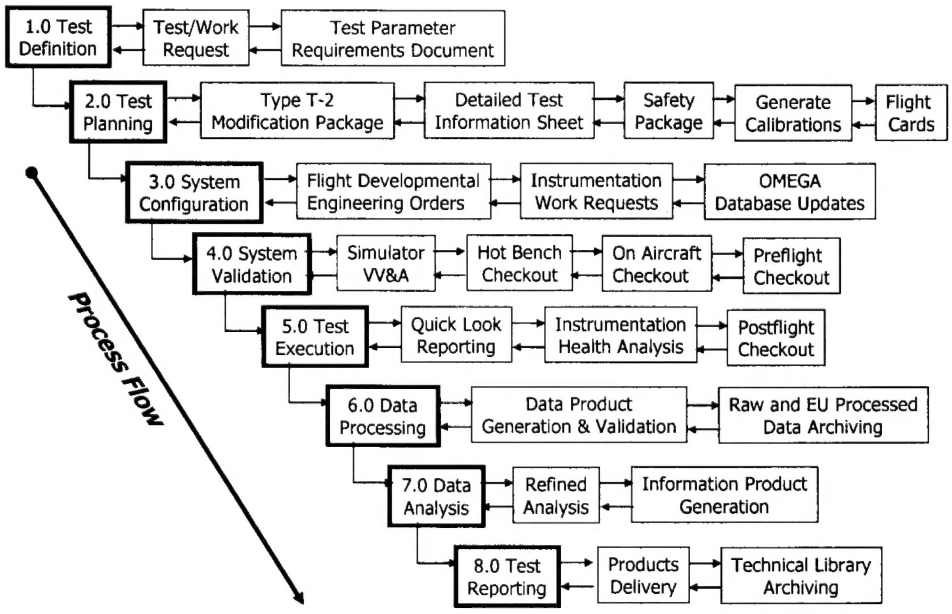
Messrs. Paul Ferrill, Bill Kubel, Jerry Gross, and Ken Ray defined our end-state information management and data processing architecture needs with assistance from the entire team. Ms. Michelle Baldonado coordinated range requirements. This team was assisted with world-class expertise from General Dynamics (formerly Veridian), EMC$^2$ (formerly Data General), Symvionics, and our JT3 support contract team members.

## DISCUSSION OF THE TECHINICAL SOLUTION.

The end result was a coordinated deployment plan approved by management on February 18, 2004, and since then, has been effectively prosecuted under the management of now First Lieutenant Perez.

Detailed decomposition of the mission support process was performed; from test definition through test reporting for any individual C-17 FOFTP element. A summary of the typical C-17 FOFTP mission process is provided in Exhibit E. Inter-relationships and dependencies were established. Common tools were identified and mapped; these became the basis for the requirements for an end-state ETDMS.

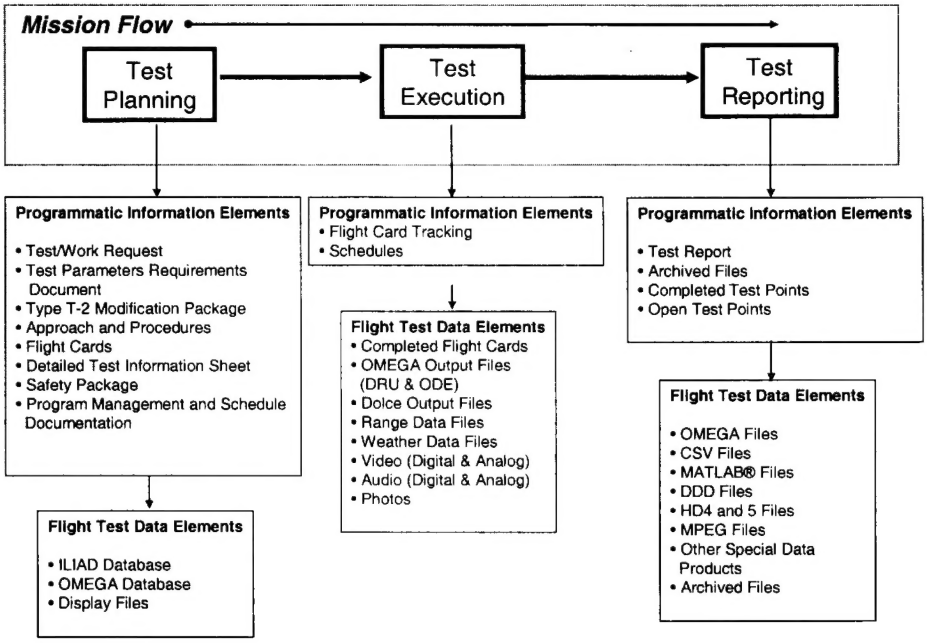
**Exhibit E: Mission Support Processes**




The C-17 FOFTP business process was then mapped with the stakeholders identified for each phase: (1) test planning; (2) test execution; and (3) test reporting. This created our subject matter expert pool and the business flow needed to support the C-17 FOFTP

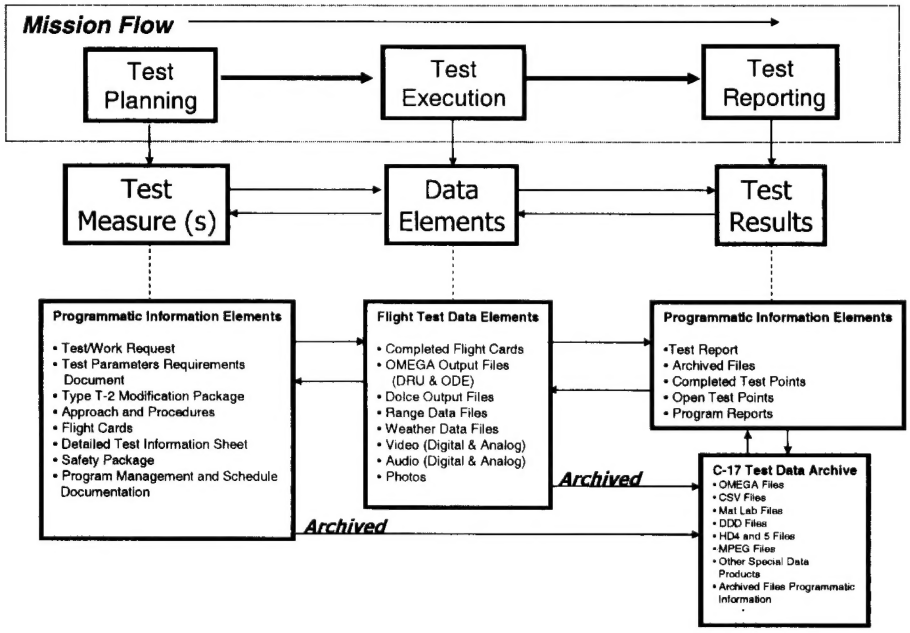
mission. Exhibit F documents that business process. This also set the 'goal' for the C-17 test data archive project.

**Exhibit F: C-17 Business Process**




The 'goal' was set at correlation and traceability between all program phases matching the programmatic information with flight test data elements from cradle-to-grave for any C-17 FOFTP element. Exhibit G provides an overview of our definition of the C-17 test data archive solution.

**Exhibit G: Goal: Correlation and Traceability**



This initiative managed by Ms. Karen Richards, supported by our part-time helper Ms. Shirley Sakamoto organized and indexed over 12,000 documents and other data media. Over 14 tons of excess document copies were shipped and shredded. Critical reports were digitized and available now in electronic format to engineers. On-demand scanning of total program reporting is institutionalized and available upon request. Eighteen hundred 14-inch magnetic tapes in storage were shipped and consolidated with 3,800 tapes in the Boeing Full Scale Engineering Development (FSED) Library. A few thousand VHS and super-8 videotapes were sorted, indexed by year and tail number, and are now available within 5 hours of data request.

Information is now available to engineers in less than 5 hours upon request. In addition to C-17 FOFTP information, Ms. Richards and Ms. Sakamoto expanded the effort on their own initiative and indexed all heavy aircraft flight test programs conducted at Edwards AFB. These include C-130, C-135, HH-60, and C-5 airframes.

We seek to address concerns with our LiveLink™ deployment configuration in FY 2005 with a "standalone instance" basing, mirroring that which is currently deployed for the Airborne Laser Laboratory (ABL) test platform.

Objective 2: Improve Data Analysis (Telemetry) Toolset and Products; Train Users.

We set multiple goals here and have obtained both. We deployed the General Dynamics-Veridian Operational Data Environment tool with 6 TB of on-line storage utilizing the Series 3000 Leading Edge processor. Combined with use of the current OMEGA™ product line, we reduced data processing time by an order of magnitude. We deployed a parallel 1 GB network and an additional 12 TB storage array to meet the challenge of processing digital video data collected in IRIG Chapter 10 format. Messrs. Paul Ferrill, Reuben Nelson, Christopher Coleman, Dennis Rhods, and Paul Ward spearhead these activities.

Mr. Reuben Nelson addressed the training issue. He established a training hub that allows engineers to pre-fly missions using archived flight-test data. Now, engineers can pre-mission validate displays and data products, walking off the test aircraft with quick look products.

Objective 3: Modernize Legacy Databases/Applications (Measurands, Calibrations, Generation of the Test Parameter Requirements [TPR] Document).

We were managing this information using an Oracle™ toolset resident from the mid-1990s. Three separate, non-relational databases where in use. We modified the existing instrumentation loading, integration, analysis, and decommutation (ILIAD) tool to track our parameters, issue the TPR, and integrate the business process. Final verification and accreditation is now in progress with switchover due in late 2004.

Objective 4: Fix the Test Planning and Test Point Tracking User Interface

Initial solution of this problem area proved trivial. An existing Test Integration Generation and Reporting System (TIGARS) tool existed in FOXPRO™ database

format; however, not supported in the current Government IT world. We purchased the last remaining used copy of FOXPRO™ Version 8.0 from www.amazon.com to provide immediate local access by Government users.

Subsequently, we found that nobody wants to use the tool and they have transitioned to other tools; we therefore went forward and eliminated this requirement integrating its replacement under Objective 5, Implement the Approved ETDMS Framework.

Objective 5: Implement the Approved ETDMS Framework.

Faced with multiple problems in implementation and deployment, our team created a commercial website to garner feedback from the user community (www.etdms.com). At a cost of approximately $200 per year, we successfully fielded prototype capabilities to encourage user feedback.

We altered our initial design to meet IT requirements for security certification and accreditation (C&A).

The desired end-state is shown in Exhibit I; we seek to achieve this by the end of FY 2005. Four semi-linked networks are defined: (1) Edwards 2K Domain; (2) Edwards BSX Domain (Business Enterprise Network); (3) Building 1830A Data Net 2 Domain; and (4) the Boeing Long Beach Domain. We hope to link the Edwards 2K Domain with the Boeing Long Beach Domain via Virtual Private Network (VPN) type interface before the end of 2004. Both already have access to the existing LiveLink™ repository via the worldwide web (www.bsx.edwards.af.mil). Data Net 2 Domain will remain unlinked due to the large volumes of data processed; data and products can be selectively placed on the indicated networks employing the USB 2 Buslink "sneaker net" method.

Exhibit J shows one initial success increasing online storage from 95 GB to over 15 TB available as of this writing.

**Exhibit I: FY 2005 Architecture End State**

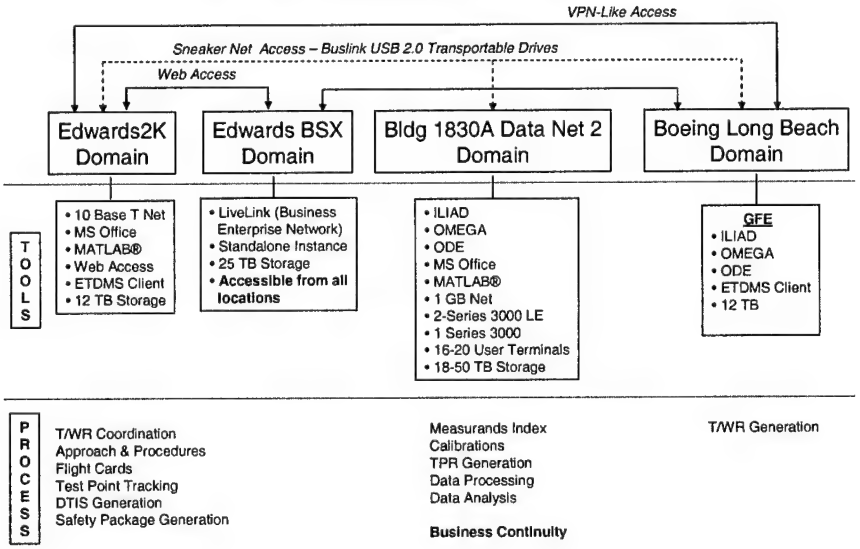
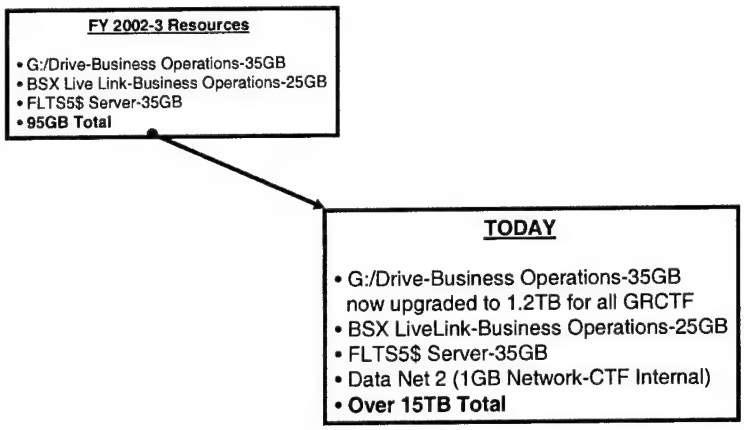


**Exhibit J: FY 2004 Status and Vector**




## SUMMARY.

We stand on schedule and within cost boundaries as of September 5, 2004. Technical implementation has been hindered by the many Government imposed regulations in the IT arena, but in most cases, adequate workarounds were available. Use of the USB 2.0 Buslink drives allows transport of data between networks while we await VPN-type access; we currently study methods of data transport from remote sites utilizing approved NIPRNET and SIPRNET protocols. Also, we advanced recently, processing video data in the IRIG Chapter 10 format producing both DVD-based and MPEG data products; next, we seek to next correlate these with mission data bus information for post-mission playback. Additionally, we have achieved our goals of making historical information available to our engineers. Finally, as a consequence to much labor and innovation, the vision of making data and information available at individuals' workstations appears achievable.



# C-17 Test Data Archive

## Deployment of the Business Enterprise C-17 Information and Test Data Management System

**Approved for public release: distribution is unlimited**


7 September 2004

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412 TW/DRP, Edwards AFB, CA

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412 TW/ENIO, Edwards AFB, CA

**Original Date - February 2004**

# Agenda

- [ ] Problem/Scope
- [ ] Technical Approach
- [ ] Schedule
- [ ] Summary

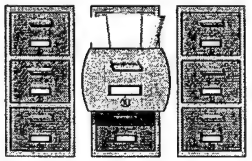
# The Problem

## Users

- C-17 IPT
- Global Reach CTF
- Program Office
- Air Mobility Command
- Boeing
- NASA-Dryden and Ames Centers
- WSMR Partnership
- Others

**Communications Links**

**Programmatic Information**

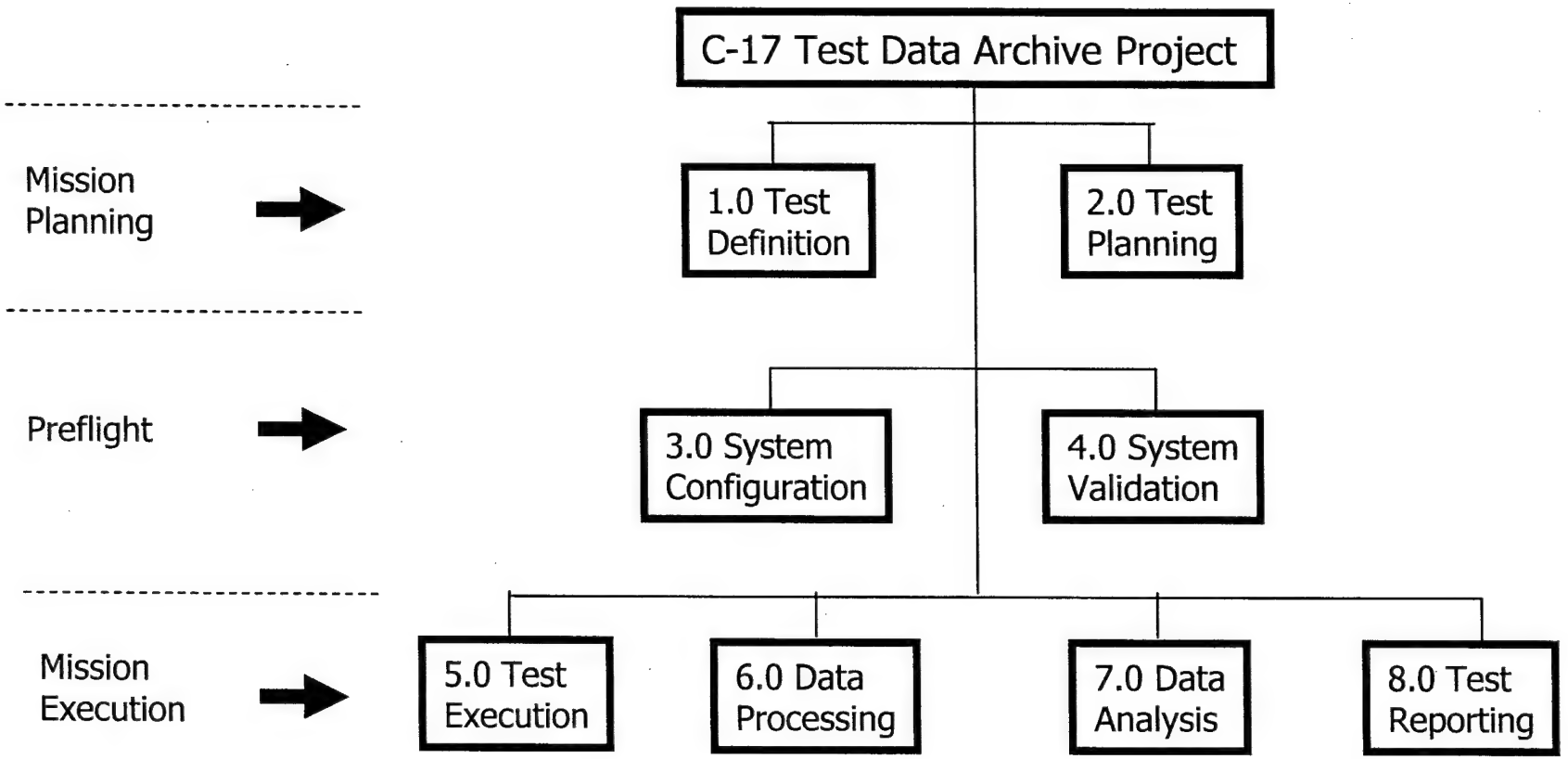


- T/WR
- Test Plans
- Test Reports
- The "Job Books"
- Everything Else

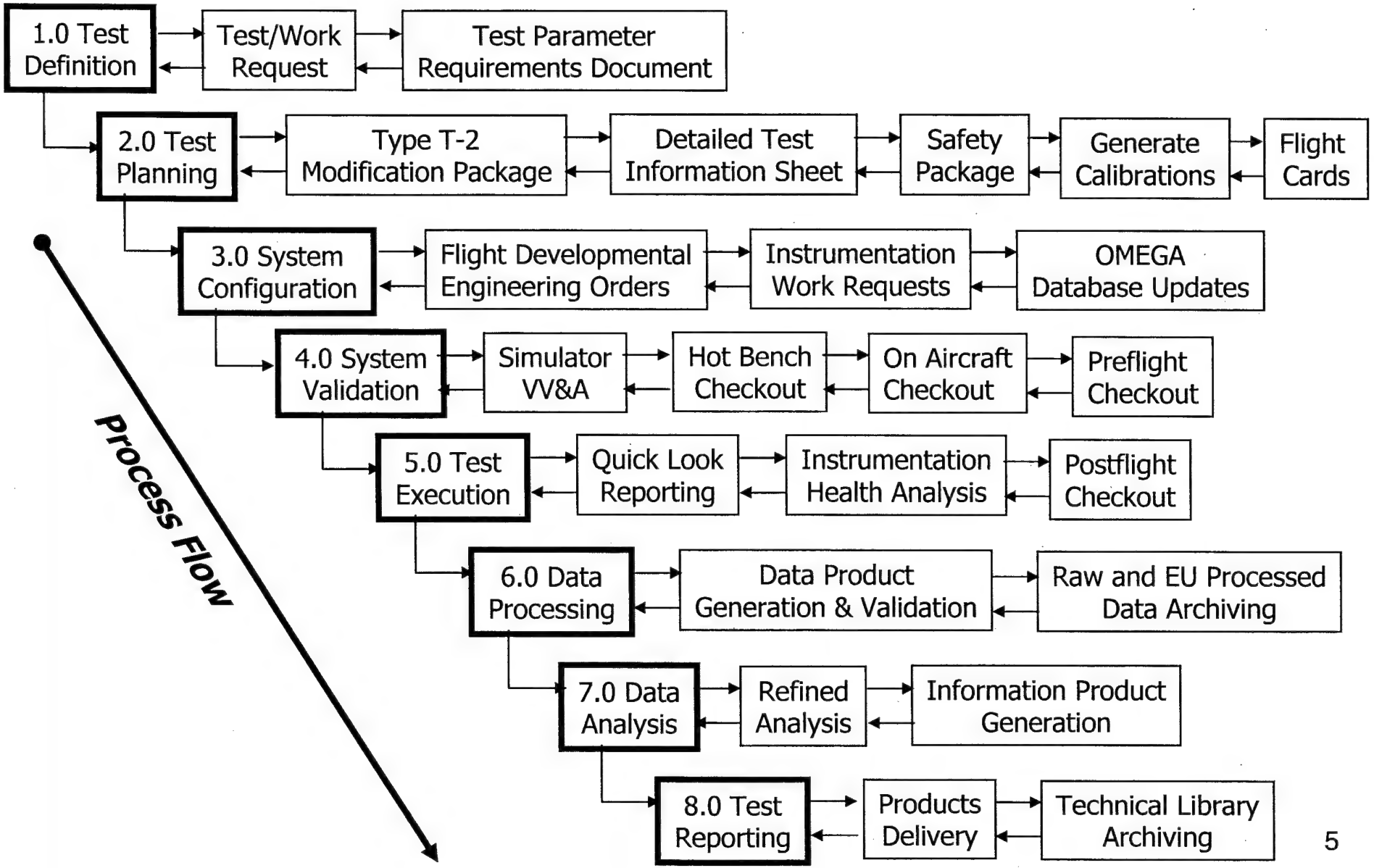
**Test Data Raw and Processed**

- Bulk Data (Analog and Digital)
- Video and Audio Data
- Range Data
- Human Factors Data

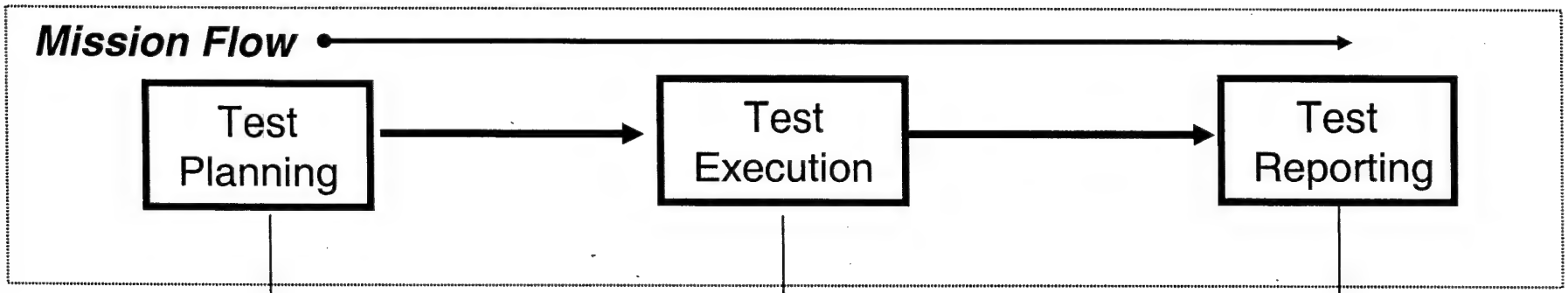
# Work Breakdown Structure



# Mission Support Processes



# Scope – C-17 Business Process




**Programmatic Information Elements**

- Test/Work Request
- Test Parameters Requirements Document
- Type T-2 Modification Package
- Approach and Procedures
- Flight Cards
- Detailed Test Information Sheet
- Safety Package
- Program Management and Schedule Documentation

**Flight Test Data Elements**

- ILIAD Database
- OMEGA Database
- Display Files

**Programmatic Information Elements**

- Completed Flight Cards

**Flight Test Data Elements**

- OMEGA Output Files (DRU & ODE)
- Dolce Output Files
- Range Data Files
- Weather Data Files
- Video (Digital & Analog)
- Audio (Digital & Analog)
- Photos

**Programmatic Information Elements**

- Test Report
- Archived Files
- Completed Test Points
- Open Test Points

**Flight Test Data Elements**

- OMEGA Files
- CSV Files
- MATLAB® Files
- DDD Files
- HD4 and 5 Files
- MPEG Files
- Other Special Data Products
- Archived Files

# Scope – Amount of Information

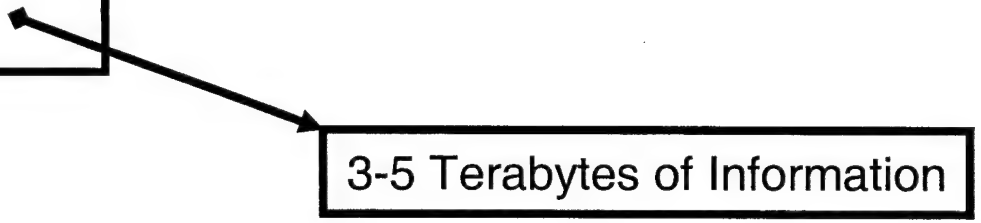
**Programmatic Information Elements**

- Test/Work Request (T/WR)
- Test Parameters Requirements Document (TPR)
- Type T-2 Modification Package
- Approach and Procedures (A&P)
- Flight Cards (FC)
- Detailed Test Information Sheet (DTIS)
- Safety Package
- Program Management and Schedule Documentation
- Completed Flight Cards
- Test Report
- Archived Files

**Program Job Book:** Approval of the T/WR initiates establishment of the Job Book for the effort at hand.

The Job Books for individual C-17 FOFTP elements reside on the Edwards Business Enterprise Network accessible at http://www.bsx.edwards.af.mil.

Projects in draft reside on the local G: drive. Each Job Book is the centralized repository for all information associated with the T/WR; this information includes the Approach and Procedures, Flight Cards, Detailed Test Information Sheet, Safety Package, and Reports.



# Scope – Amount of Information

**Flight Test Data Elements**

- ILIAD Database
- OMEGA Database
- Display Files
- OMEGA Output Files (DRU & ODE)
- Dolce Output Files
- Range Data Files
- Weather Data Files
- Video (Digital & Analog)
- Audio (Digital & Analog)
- Photos
- OMEGA Files
- CSV Files
- MATLAB® Files
- DDD Files
- HD4 and 5 Files
- MPEG Files
- Other Special Data Products
- Archived Files

**MIL-STD-1553 Data Bus:** Currently seven busses are instrumented on the designated test aircraft; two additional communications data busses will be instrumented in the future.

- M1 / M2 busses produce ~ 350 MB per hour each
- F1 / F2 / F3 / F4 produce ~ 250 MB per hour each
- W1 ~ 300 MB per hour
- ***Total 1553 ~ 2GB per hour***

**ARINC 429 Data Bus:** On the designated test aircraft, 36 high and low speed busses are captured.

- ***Aggregate total ~ 300 MB per hour***

**Pulse Code Modulated (PCM) Analog Data:** Three PCM streams are captured on the designated test aircraft, each at a data rate of 640KBPS.

- ***Aggregate total ~ 900 MB per hour***

**Analog and Digital Video Data:** Currently VHS and Super 8 tape cassettes record audiovisual data; transition to solid state digital recorders has been implemented on the second test aircraft.

- On demand copy of VHS to DVD format capability exists
  - Converted VHS/Super 8 Data ~ 2 GB per hour for specified time slices consolidating 3 video streams
  - Digital Solid State Recorder (Heim Brand) ~1.1 GB per hour per video stream.

*More to come* ⟶

# Scope – Amount of Information

**Flight Test Data Elements**

- ILIAD Database
- OMEGA Database
- Display Files
- OMEGA Output Files (DRU & ODE)
- Dolce Output Files
- Range Data Files
- Weather Data Files
- Video (Digital & Analog)
- Audio (Digital & Analog)
- Photos
- OMEGA Files
- CSV Files
- MATLAB® Files
- DDD Files
- HD4 and 5 Files
- MPEG Files
- Other Special Data Products
- Archived Files

**ILIAD and OMEGA Databases:** For each test series profile, assume 100GB of supporting data.

**Data Products:** For data bus and PCM instrumentation, archives will be twice the size of data/flight hour collected (best case). Video experience to date is on the same level of magnitude.

**Still Photo Data:** On-aircraft, in-flight or post-mission digital camera data indicates a file size ~ 0.5 GB per photo for high quality archives.

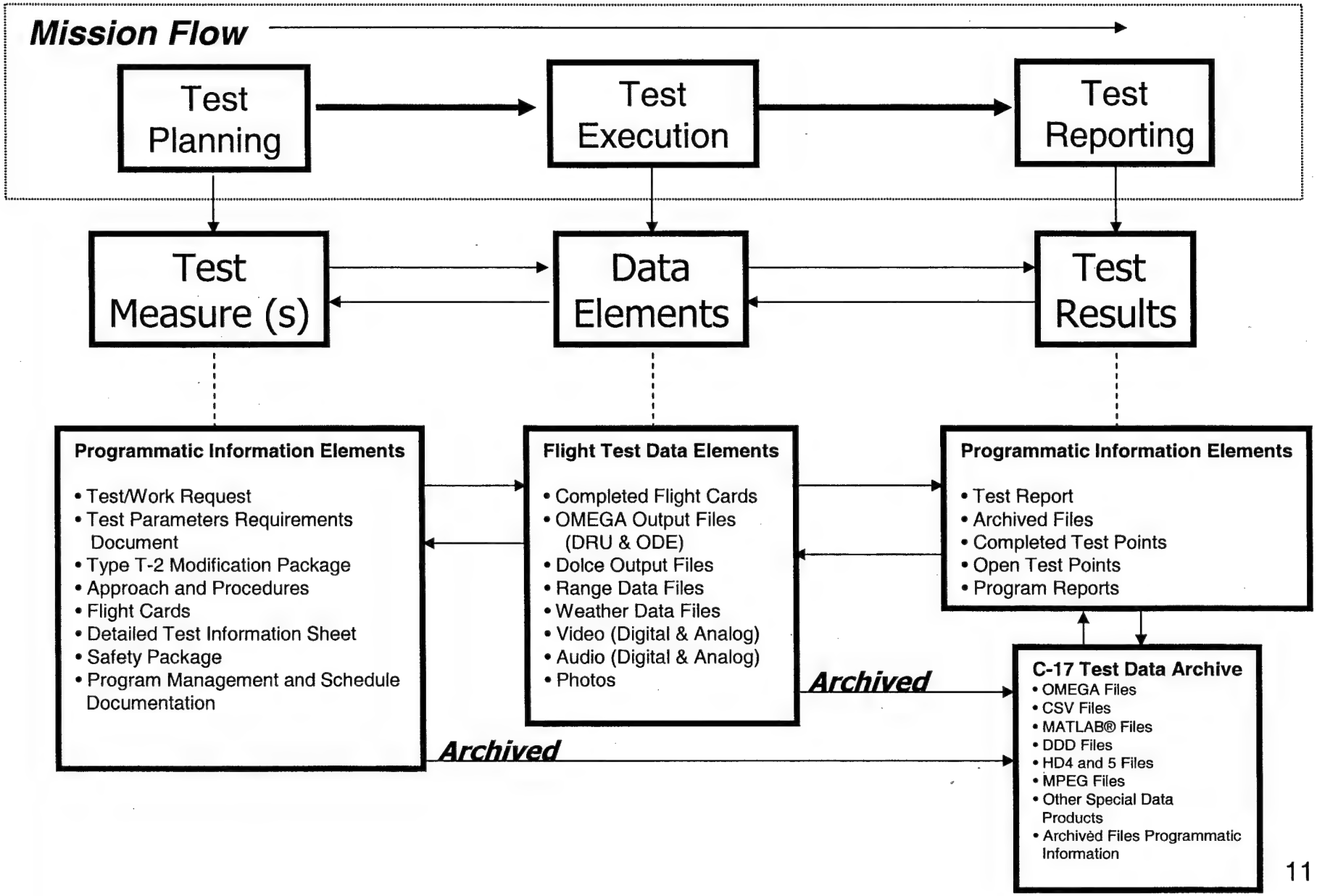
**Range Radar/Beacon TSPI Data:** Recent parachute airdrops collected FPS-16 data from a single range radar.
Processed, this data indicates a file size ~ 1 MB/mission.
Additional data processing reduces this to ~ of 0.5 MB/mission.

**Range Video Support:** White Sands Missile Range (WSMR), New Mexico, provides state-of-the-art digital video in support of munitions programs.
This capability is coming soon to other DOD ranges.
Up to six cameras are used to score Air Force bomb drops and guided air-to-ground missile performance.
Typically 8 seconds is recorded for each test point or event.
Our colleagues have provided the following information. Current digital camera is 1 MB/frame (1024x1024), 1,000 frames per second, net result on the order of 62.9 GB/minute/camera.
If we have 20 cameras deployed, then we're looking at ~1.26 TB/minute.
The next generation cameras are 4 MB/frame & higher frame rates.
But assume still 1,000 frames per second, and then we're looking in the neighborhood of 5 TB/minute.

## Special Interest Item

- Studying methods for transfer of data via NIPRNET and SIPRNET
- 6-8 options being examined now
- Anticipate demonstration in early FY 2005

# Goal: Correlation and Traceability



# FY 2004 Objectives

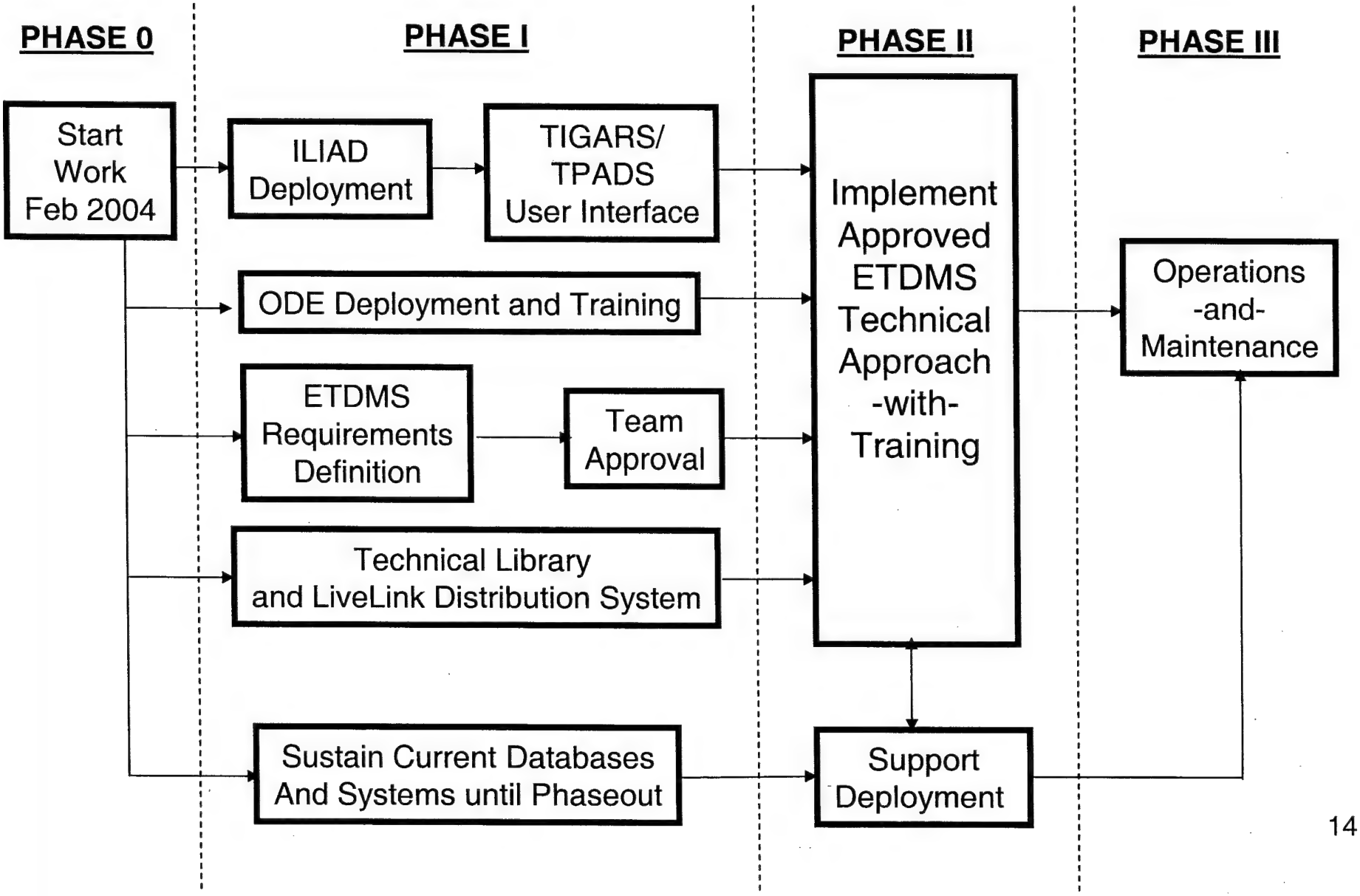
- Establish C-17 Technical Library; Complete Deployment of LiveLink Distribution System
- Improve Data Analysis (Telemetry) Toolset and Products; Train Users
- Modernize Legacy Databases/Applications (Measurands, Calibrations, TPR)
- Fix the TIGARS User Interface
- Implement Approved ETDMS Framework

  *(ETDMS = Enterprise Test Data Management System)*

# Agenda

- [x] Problem / Scope
- [ ] Technical Approach
- [ ] Schedule
- [ ] Summary

# Technical Approach



# Objective 1

Establish C-17 Technical Library; Complete Deployment of LiveLink Distribution System

# Accomplishments to Date

- Sorted and Grouped Files: 12,000 plus documents examined.
- Indexed the Documents: Since responded to over 200 information requests from C-17 team members.
    - Digitally scanned all available AFFTC documents
    - Made available on the G: Drive
    - Removed not required and duplicate documents
        - 600 cartons sent for shredding
            - 600 cartons x 40 pounds/carton = 24,000 pounds of excess paperwork reduced
- Sorted on the order of 3,800 C-17 videotapes
    - Indexed by tail number and year
    - Less than 5 hours required to respond to info requests
    - On-demand DVD+R conversion capability implemented, if customer requires
- Sorted on the order of 10,000 C-17 photographs
    - Partially indexed by tail number and year;
    - Less than 5 hours required to respond to info requests;
    - On-demand scan to JPEG format implemented, if customer requires
- Consolidation of FSED and FOFTP 14" magnetic tape libraries
    - Complete indexing accomplished
    - 600 of 1,800 tapes moved to date; at 12 pounds per tape-3.6 tons
    - Remaining 1,200 tapes now archived in consolidated FSED/FOFTP Library

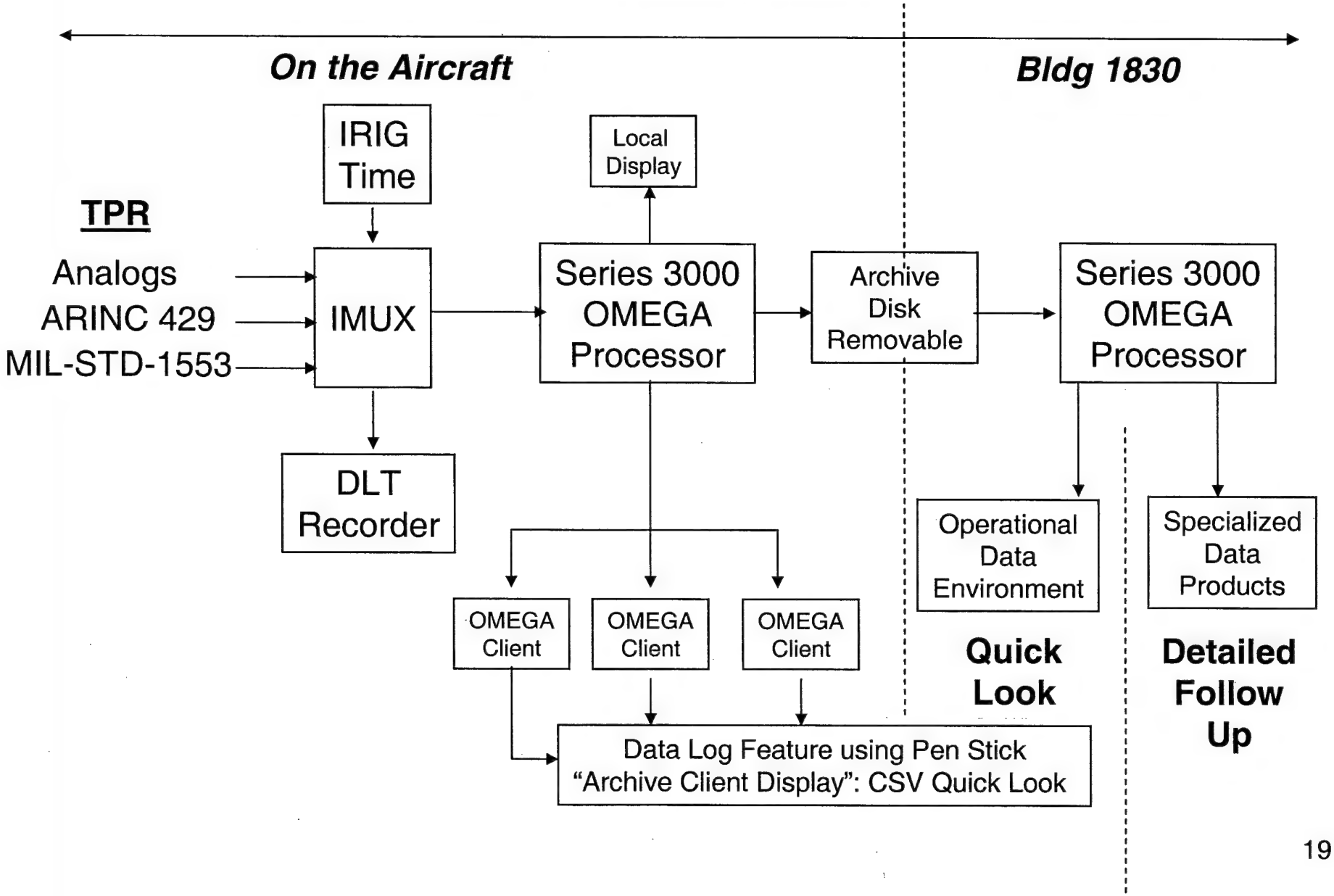
# Accomplishments to Date

- Scope increased to integrate all CTF programs

# Objective 2

Improve Data Analysis (Telemetry) Toolset and Products; Train Users

# C-17 Data Chain



# Accomplishments to Date

## OMEGA Data Environment (ODE)

- Deployed toolset 3 months ahead of schedule
- Toolset in-use for analysis of flight test data
- Refinements in process
- Training of core users completed

## Objective 3

# Modernize Legacy Databases (Measurands, Calibrations, TPR)

# Accomplishments to Date

**Instrumentation Loading, Integration, Analysis, and Decommutation (ILIAD)**

- Toolset delivered 2 weeks late
- Currently undergoing verification and validation
- Anticipate IOC by 30 Sep 04
- User training during September 04

# Objectives 4 and 5

## Phase I: Fix the TIGARS User Interface

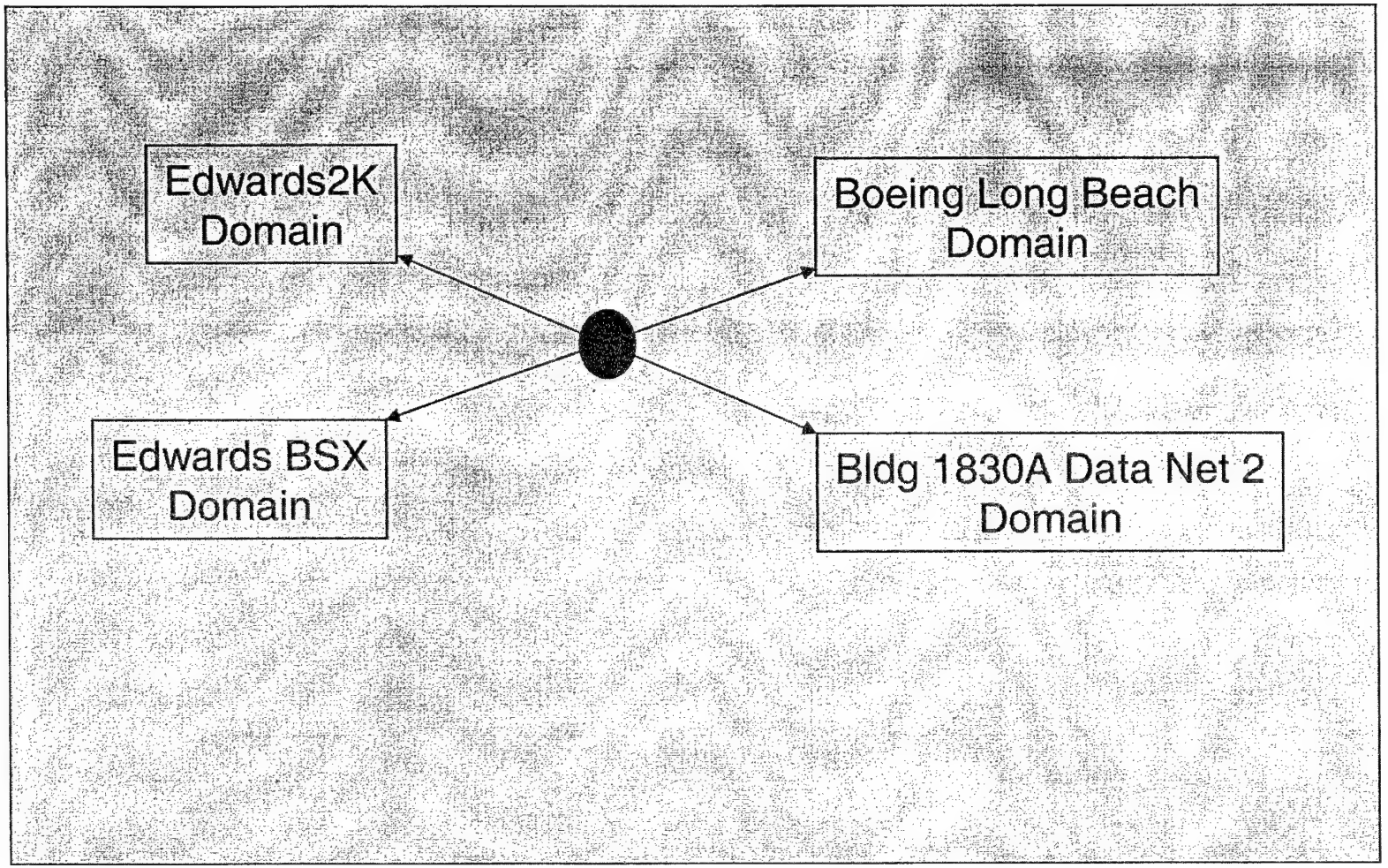
## Phase II: Implement Approved ETDMS Framework

# Accomplishments to Date

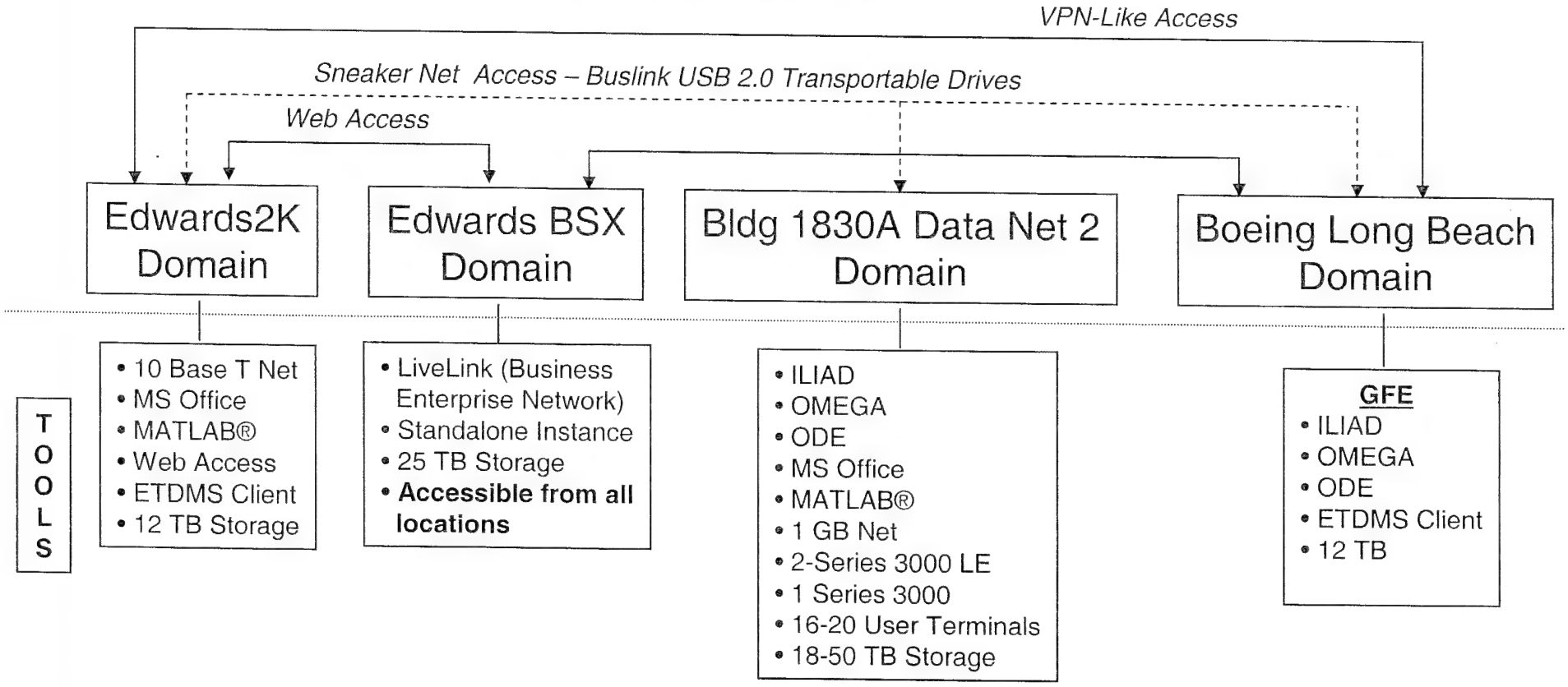
**Test Integration Generation and Reporting System (TIGARS)**

- Commercially purchased FoxPro; address immediate concerns
- Testing beta version of TIGARS replacement
- Set up a demonstration website to obtain feedback from users
- Deployed 1 GB intranet with 15 terabytes of storage arrays

# Planned Architecture



# FY 2005 Architecture End State




**PROCESS**

T/WR Coordination
Approach & Procedures
Flight Cards
Test Point Tracking
DTIS Generation
Safety Package Generation

Measurands Index
Calibrations
TPR Generation
Data Processing
Data Analysis

**Business Continuity**

T/WR Generation

# FY 2004 Status and Vector

**FY 2002-3 Resources**

- G: Drive-Business Operations-35GB
- BSX Live Link-Business Operations-25GB
- FLTS5$ Server-35GB
- **95GB Total**

**TODAY**

- G: Drive-Business Operations-35GB now upgraded to 1.2TB for all GRCTF
- BSX LiveLink-Business Operations-25GB
- FLTS5$ Server-35GB
- Data Net 2 (1GB Network-CTF Internal)
- **Over 15TB Total**

# Agenda

- [x] Problem / Scope
- [x] Technical Approach
- [ ] Schedule
- [ ] Summary

# Schedule

| Objective | Focus Area | IOC Target Date |
|---|---|---|
| 1 | Establish C-17 Technical Library; complete deployment of LiveLink Distribution System | December 2004 |
| 2 | Improve Data Analysis (Telemetry) Toolset and Products; Train Users | June 2004 (Completed 1 Apr 04) ✓ |
| 3 | Modernize Legacy Databases (Measurands, Calibrations, TPR) | June 2004 (Completed 30 Jul 04) ✓ |
| 4 | Fix the TIGARS User Interface | June 2004 (Completed 15 Apr 04) ✓ |
| 5 | Implement approved ETDMS framework | December 2004 |

# Agenda

- [x] Problem/Scope
- [x] Technical Approach
- [x] Schedule
- [ ] Summary

# Summary

- Within 120 days of meeting all schedule objectives
- Remain within budget allocations
- Demonstrations and user feedback being used to refine original requirements
- Technical deficiencies are identified and are being addressed systematically
- Leading edge feedback supported recent KC-135 Wheels-Tires-Brakes testing

# Lessons Learned

- User Requirements – Engineer's desk versus data hub
- DoD Security Requirements – Research up front
- GOTS/COTS Products – Expect to improvise; nothing delivered at 100%
- Coordination – Do not underestimate, more is better
- Support – Go hands-on with all team members
- Contracts – Build in flexibility

# Agenda

- [x] Problem / Scope
- [x] Technical Approach
- [x] Schedule
- [x] Summary

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